CLAIMS

[Claim(s)]

[Claim 1] So that current n times the size of the switching transistor by which differential connection was made and the current which flows into said switching transistor which a driving pulse is supplied to a control electrode and switched to it may flow into a laser diode The laser diode drive circuit characterized by having the constant current circuit connected between said switching transistor and said laser diode.

[Claim 2] Said constant current circuit is a laser diode drive circuit according to claim 1 characterized by being current Miller circuit.

[Claim 3] Said constant current circuit is a laser diode drive circuit according to claim 1 characterized by being a WIRUSON constant current circuit.

[Claim 4] They are Claim 1 characterized by building said switching transistor in IC and arranging said constant current circuit besides said IC, and a laser diode drive circuit given in 2 or 3.

[Claim 5] When recording or reproducing data to a record medium, drive said laser diode, and [the control electrode of said switching transistor] The laser diode drive circuit according to claim 1 to 4 characterized by supplying a RF superposition pulse when reproducing said data, while said driving pulse is supplied, when recording said data.

[Claim 6] [said control electrode of said switching transistor] When a module is connected and said module records said data the output of the delay circuit where only predetermined time delays for it and outputs an input, and said delay circuit, or among said driving pulses, The laser diode drive circuit according to claim 5 characterized by choosing the output of said delay circuit, supplying said delay circuit, and having the selector which generates said RF superposition pulse when choosing and outputting said driving pulse and reproducing said data.

[Claim 7] When recording or reproducing data to a record medium, drive said laser diode, and [the node of said switching transistor and said constant current circuit] The laser diode drive circuit according to claim 1 to 4 characterized by connecting the module which generates the RF superposition pulse impressed to said laser diode when reproducing said data from said record medium.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is used for optical-magnetic disc equipment, for example, and relates to a suitable laser diode drive circuit.

[0002]

[Description of the Prior Art] Drawing 10 shows the fundamental composition of optical-magnetic disc equipment. The disk 1 is made as [rotate / with a spindle motor 2 / at the rate of predetermined]. The optical head 3 is arranged on the underside of a disk 1, and the magnetic field head 4 is arranged on the upper surface. The optical head 3 builds in the laser diode and the photodiode, irradiates the laser beam emitted from the laser diode at a disk 1, and is made as [receive / with a photodiode / the reflected light].

[0003] The LD driver 6 is controlled by a controller 5, and is made as [drive / a laser diode]. Moreover, the signal which a photodiode outputs is supplied to the signal decoder 9 and the servo

circuit 10. The signal decoder 9 decodes the inputted signal and supplies it to the controller 5. The servo circuit 10 generates a clock from the inputted signal, and is outputting it to the controller 5 and the encoder 7. Moreover, the servo circuit 10 generates a focus error signal and a tracking error signal from the inputted signal, and is made as [control / the optical head 3] corresponding to this error signal.

[0004] An encoder 7 encodes the write data supplied from a controller 5, and supplies it to the magnetic field head driver 8. The magnetic field head driver 8 drives the magnetic field head 4, and is made as [make / a predetermined magnetic field / impress to a disk 1]. It connects with the host computer which is not illustrated and the controller 5 is made as [control / the record and reproduction motion to a disk 1].

[0005] Next, the operation is explained with reference to drawing 11 . A disk 1 rotates at the rate of predetermined with a spindle motor 2 at the time of record or playback mode. Write data is supplied to a controller 5 from a host computer at the time of a recording mode. This write data is supplied and encoded by the encoder 7, and is supplied to the magnetic field head 4 through the magnetic field head driver 8. Thereby, the magnetic field head 4 generates the magnetic field of a n pole, when recording logic 1, for example, and when recording logic 0, it generates the magnetic field of S pole (drawing 11 (a)).

[0006] On the other hand, a controller 5 controls the optical head 3 through the LD driver 6, and makes a laser diode generate a laser beam in the timing which records logic 1 and 0 (drawing 11 (b)). As a result, logic 1 and 0 will be recorded by the optical MAG target on a disk 1.

[0007] On the other hand, a controller 5 makes the laser diode built in the optical head 3 through the LD driver 6 turn on continuously fundamentally at the time of reproduction mode. However, a RF signal is superimposed in order to control this, since the noise what is called by a SCOOP effect will occur if the light is made to switch on continuously actually. As a result, the laser beam turned on or switched off by a RF is irradiated by the disk 1.

[0008] The photodiode built in the optical head 3 receives the reflected light from a disk 1, and outputs the detection signal. The signal decoder 9 separates MO component from the signal which a photodiode outputs, decodes this, and outputs it to a controller 5 as read data. This data is transmitted to the host computer which is not illustrated from a controller 5.

[0009] At the time of the above record and reproduction mode, the servo circuit 10 detects the RF signal which a photodiode outputs, and generates a focus error signal and a tracking error signal based on an astigmatism method or the push pull method. And corresponding to this error signal, the actuator built in the optical head 3 is driven. This drives the optical head 3 to a focusing direction and a tracking direction.

[0010] Moreover, the servo circuit 10 extracts a clock component from an RF signal, and supplies it to the controller 5 and the encoder 7. A controller 5 and an encoder 7 perform processing of write data and read data on the basis of this clock.

[0011] Next, with reference to drawing 12 , the example of composition of the laser diode drive circuit which drives a laser diode is explained. Differential connection of the NPN transistor 21 and 22 is made, and the emitter is grounded through the NPN transistor 23 and resistance 26. A laser diode 24 is connected to the collector of the NPN transistor 21, and resistance 25 is connected to the collector of the NPN transistor 22. The module 27 is connected to the collector of the NPN transistor 21.

[0012] Next, the operation is explained. Voltage Vapc is impressed to the base of the NPN transistor 23 at the time of a recording mode. As a result, between the collector emitters of the NPN transistor 23, the constant current corresponding to this voltage Vapc flows. On the other hand, the voltage data1 and data2 corresponding to record data of reversed polarity are impressed to the NPN transistor 21 and the base of 22, respectively.

[0013] That is, when the base of the NPN transistor 21 is a high level, the base of the NPN transistor 22 serves as a low. On the contrary, when the base of the NPN transistor 21 is set to a low, the base of

the NPN transistor 22 serves as a high level. The direction where the voltage of a high level was impressed to the base turns on the NPN transistor 21 and 22, and the direction where the voltage of the low was impressed turns them off. When the NPN transistor 21 turns on, the constant current specified with the NPN transistor 23 flows in a laser diode 24, the NPN transistor 21, the NPN transistor 23, and the path of resistance 26. A laser diode 24 will be turned on at this time.

[0014] On the other hand, when the NPN transistor 22 turns on, current flows in resistance 25, the NPN transistor 22, the NPN transistor 23, and the path of resistance 26. A laser beam is not generated in order that current may not flow into a laser diode 24 at this time (the light is put out).

[0015] On the other hand, the NPN transistor 21 is continuously turned on at the time of reproduction mode, and the NPN transistor 22 is turned off continuously. And a module 27 outputs a RF superposition signal with a frequency of 500MHz, for example, and impresses it to the cathode of a laser diode 24. As a result, a laser diode 24 corresponds to this RF superposition signal, and turns on and turns off, and a laser beam blinks by a RF.

[0016]

[Problem to be solved by the invention] In the conventional laser diode drive circuit, the laser diode 24 was made in this way as [connect / with the NPN transistor 21 by which differential connection was made, and one side of 22]. As a result, when laser was turned on, from the first, when the light was put out, the current of the same value as the case where the light is always switched on flowed, and the technical problem to which power consumption becomes large more than needed occurred.

[0017] This invention is made in view of such a situation, and lessens power consumption.

[0018]

[Means for solving problem] The NPN transistor 31 as a switching transistor by which differential connection was made which a driving pulse is supplied to the base as a control electrode, and switches the laser diode drive circuit of this invention, and 32. It is characterized by having the NPN transistor 31 and the constant current circuit 36 connected between 32 and a laser diode 37 so that current n times the size of the NPN transistor 31 and the current which flows into 32 may flow into a laser diode 37.

[0019] The constant current circuit 36 can be made into current Miller circuit. Moreover, the constant current circuit 36 can be made into a WIRUSON constant current circuit. Furthermore, the NPN transistor 31 and 32 are made to build in IC, and the constant current circuit 36 can be arranged besides IC.

[0020] When driving the laser diode 37 used when recording or reproducing data to a record medium, when recording data on the NPN transistor 31 and the base of 32, a driving pulse is supplied to them, and when reproducing data, a RF superposition pulse can be supplied.

[0021] [the NPN transistor 31 and the base of 32] When recording data the output of the delay circuit 86 which connects a module 38, and only predetermined time is delayed in an input and outputs this module 38, and the delay circuit 86, or among driving pulses. When choosing and outputting a driving pulse and reproducing data, the output of the delay circuit 86 can be chosen, the delay circuit 86 can be supplied, and the selector 81 which generates a RF superposition pulse can constitute.

[0022] Or when recording or reproducing data to a record medium and driving a laser diode 37 again. When reproducing data to the node of the NPN transistor 31, and the 32 and the constant current circuit 36 from a record medium, the module 38 which generates the RF superposition pulse impressed to a laser diode 37 can be connected to it.

[0023]

[Function] In the laser diode drive circuit of the above-mentioned composition, when [of the NPN transistor 31 or 32] current flows on the other hand (for example, 32), the n-time-as many current as this flows into the laser diode 37 connected through the constant current circuit 36. Therefore, the current which always flows can be set to 1/n of current supplied by the laser diode 37.

[0024]

[Working example] The laser diode drive circuit of this invention can also be used, for example in optical-magnetic disc equipment. In this case, the fundamental composition and operation of the optical-magnetic disc equipment which can be set are the same as that of the case where it is shown in

drawing 10 and drawing 11.

[0025] Drawing 1 shows the example of composition of the laser diode drive circuit of this invention. In this example, differential connection of the NPN transistor 31 and 32 is made, and the common node of that emitter is grounded through the NPN transistor 33 and resistance 35. The collector of the NPN transistor 31 is connected to the predetermined reference potential Vcc through resistance 34. Moreover, the collector of the NPN transistor 32 is also connected to the reference potential Vcc through the constant current circuit 36. The predetermined voltage Vapc is impressed to the base of the NPN transistor 33, and it is made in the NPN transistor 31 and the base of 32 as [impress / the signal data1 or data2 corresponding to the record data of reversed polarity / mutually /, respectively].

[0026] Moreover, the laser diode 37 is connected to the constant current circuit 36. And the module 38 is connected to the node of the constant current circuit 36 and a laser diode 37.

[0027] Next, the operation is explained. Since the predetermined voltage Vapc is impressed to the base of the NPN transistor 33, When setting voltage between base emitters of the NPN transistor 33 to Vbe, the current (current which flows into resistance 35) i which flows between the collector emitters of the NPN transistor 33 can be expressed with a degree type.

R35 shows the resistance of resistance 35 i= (Vapc-Vbe) / R35, in addition here.

[0028] Therefore, the current i which flows into resistance 35 is controllable on fixed current by controlling voltage Vapc on predetermined voltage.

[0029] The pulse of the reversed polarity corresponding to record data is impressed to the NPN transistor 31 and the base of 32 at the time of a recording mode. That is, when the pulse of a high level is impressed to the base of the NPN transistor 31, the pulse of a low is impressed to the base of the NPN transistor 32. Moreover, when the pulse of a low is impressed to reverse at the base of the NPN transistor 31, the pulse of a high level is impressed to the base of the NPN transistor 32.

[0030] The NPN transistor 31 and 32 are turned on when the pulse of a high level is impressed to the base, and when the pulse of a low is impressed, they are turned off. When the NPN transistor 31 turns on, current flows in the path of resistance 34, the NPN transistor 31, 33, and resistance 35, and when the NPN transistor 32 turns on, current flows in the path of the constant current circuit 36, the NPN transistor 32, 33, and resistance 35.

[0031] When current flows into the NPN transistor 32, the constant current circuit 36 operates so that the n times (n is a larger value than 1)-as many current as this may be sent through a laser diode 37. Therefore, in a laser diode 37, the NPN transistor 32 corresponds to record data (data2), and when turned on and turned off, a laser beam is generated corresponding to it.

[0032] At the time of reproduction mode, the signal of a low is always inputted into the NPN transistor 31, and the signal of a high level is always inputted into the NPN transistor 32. As a result, the constant current circuit 36 operates so that a laser diode 37 may always be driven. However, a RF superposition signal with a frequency of 500MHz is actually impressed to the anode of a laser diode 37 from a module 38, for example. As a result, a laser diode 37 is turned on and off after all corresponding to this RF superposition signal.

[0033] Drawing 2 shows the example of composition of the constant current circuit 36. The constant current circuit 36 is constituted by the PNP transistor 41 and 42 in this example. The emitter of the PNP transistor 41 is connected to the reference potential Vcc, and the collector is connected to the collector of the NPN transistor 32. The base of the PNP transistor 41 is connected to the collector of the PNP transistor 41 while connecting with the base of the PNP transistor 42.

[0034] When current predetermined in the property to the emitter collector of the PNP transistor 41 flows, the PNP transistor 41 and 42 are set up so that the n-time-as many current as this may flow into the emitter collector of the PNP transistor 42. That is, in this example, the constant current circuit 36 is constituted by the current Miller circuit which serves as the PNP transistor 41 from 42, and that property is set up so that the ratio of that I/O current may be set to one pair n.

[0035] Drawing 3 shows other examples of composition of the constant current circuit 36. The constant current circuit 36 is constituted by the WIRUSON constant current circuit in this example. That is, the emitter of the PNP transistor 51 is connected to the reference potential Vcc, and the collector is connected to the collector of the NPN transistor 32. The base of the PNP transistor 51 is connected to the base and the collector of the PNP transistor 52. The emitter of the PNP transistor 52 is connected to the reference potential Vcc, and the collector is connected to the emitter of the PNP transistor 53.

[0036] The base of the PNP transistor 53 is connected to the collector of the PNP transistor 51, and the collector is connected to the laser diode 37. Also in this example, when predetermined current flows into the PNP transistor 51, that property is adjusted so that that n-time-as many current as this may flow into the PNP transistor 52 and 53.

[0037] Drawing 4 shows the 3rd example of the constant current circuit 36. In this example, it has composition which connected 64 to the PNP transistor 61 considered as the composition of current Miller circuit, and the emitter of 62 with resistance 63 like the PNP transistor 41 in drawing 2 , and 42, respectively. And the ratio of the resistance R63 of this resistance 63 to the resistance R64 of resistance 64 is set as n to 1, as shown in a degree type.

R63: R64=n : 1 [0038] That is, in the example of drawing 2 , although he was trying to set to one pair n the current which flows between that emitter collector by adjusting the PNP transistor 41 and the property of 42 to a predetermined value, in this example, the PNP transistor 61 and 62 are set as the same property. However, since the resistance 63 connected and the value of 64 are set as n to 1 to have mentioned above, the ratio of current which flows between the PNP transistor 61 and the emitter collector of 62 can be set as one pair n.

[0039] Like drawing 4 , as shown in drawing 2 , compared with the case where the properties of the transistor itself are made to differ mutually, it becomes easy to manufacture the direction which adjusted the current value by resistance.

[0040] The value of the resistance R34 of resistance 34 and the resistance R63 of resistance 63 can be 4.7 ohms, respectively, the resistance R35 of resistance 35 can be 1.18 ohms, and the resistance R64 of resistance 64 can be 0.78 ohm. By setting it as such a value, actuation current as shown in drawing 5 can be sent through a laser diode 37 by the laser diode drive circuit of composition of being shown, for example in drawing 4 . The rise time of a pulse is set to about 3ns, and the fall time has become about 2ns so that more clearly than drawing 5 . That is, it turns out that it can be made steep like the case where the dip of a standup and falling drives with the transistor by which differential connection was made as shown in drawing 12 .

[0041] As shown the constant current circuit 36 in drawing 4 , when it is constituted, a module 38 can be connected as shown in drawing 6 . That is, in this example, the switch circuit 71 is connected to the NPN transistor 31 and the base of 32, and it is made as [supply / the data (RF superposition pulse) and write data which were outputted to this switch circuit 71 from the module 38]. And at the time of a recording mode, the switch circuit 71 chooses write data, and at the time of reproduction mode, it is switched so that the output of a module 38 may be chosen. Thereby, a laser diode 37 drives like the case in the example mentioned above at the time of a recording mode.

[0042] Moreover, since the RF superposition pulse which replaces with write data and a module 38 outputs by the switch circuit 71 at the time of reproduction mode is chosen, At the time of reproduction mode, a laser diode 37 will be replaced with the recording pulse at the time of a recording mode (driving pulse), and will be driven corresponding to a RF superposition pulse.

[0043] The PNP transistor 62 which supplies the high current which flows into a laser diode 37, and the PNP transistor 61 which makes this and a pair will become disadvantageous if this is IC-ized. That is, if the transistor which sends a high current is IC-ized, for heat dissipation, a metal package will be needed and it will become expensive. Then, as for the PNP transistor 61, 62, resistance 63, and 64, arranging besides IC is desirable.

[0044] On the other hand, the NPN transistors 31 to 33 and resistance 35 can be arranged in IC with the switch circuit 71 and a module 38. This is because the current which flows there is small and ends. Thus, if it IC-izes, a transistor will become possible [carrying out a high speed drive more].

[0045] When it constitutes so that a module 38 may be connected to the base of the NPN transistor 31 as shown in drawing 6 , compared with the case where it connects with the anode of a laser diode 37, power consumption becomes small and the stability of a circuit increases. Furthermore, since a laser diode 37 and direct coupling are not carried out, the effect by the variation in a laser diode 37 decreases. Moreover, since the current which is flowing into the laser diode 37 becomes ****** 0 when the laser diode 37 has gone out, in order to generate a RF superposition pulse by switching, efficiency can be improved.

[0046] Moreover, in the example of drawing 6 , since it can be made the 1 chip IC except for a current Miller circuit portion, lowering and the cheap small package of heat capacity can be used for the power consumption of IC. As a result, since a laser diode drive circuit can be miniaturized and it becomes cheap also with a package and a process, it becomes possible to cut down the cost more.

[0047] The RF superposition pulse which a module 38 outputs as shown in drawing 6 , A module 38 and the switch circuit 71 can be constituted as it is shown, for example in drawing 7 , when choosing the either and supplying a write pulse to the NPN transistor 31 by which differential connection was made, and the base of 32. In this example, the switch circuit 71 is constituted by the selector 81 and the module 38 is constituted by this selector 81 and delay circuit 86.

[0048] The input terminal DA of a selector 81 is connected to the output of the delay circuit 86 while it is grounded through resistance 83. The input terminal DB is made as [ground / through resistance 84] while being made as [supply / write data]. Moreover, it is made as [input / the control signal (change signal) of Logic L] by the input terminal SEL grounded through resistance 85 at the time of Logic H and reproduction mode at the time of a recording mode. Moreover, the capacitor 82 is connected to the terminal VCC of a selector 81 while predetermined voltage (for example, 5V) is impressed. Moreover, Terminal VEE is grounded.

[0049] When Logic H is inputted into Terminal SEL (at the time of a recording mode), a selector 81 chooses the signal inputted into the input terminal DB, and is made as [output /, respectively / from the output terminals Q and QI / as a signal of an opposite phase]. Moreover, when Logic L is inputted into Terminal SEL (at the time of reproduction mode), a selector 81 chooses the signal inputted into the input terminal DA, and is made as [output / the signal of an inphase, and the signal of an opposite phase / from the output terminals Q and QI /, respectively]. The output of the output terminal QI is made as [return / to the input terminal DA / through the delay circuit 86].

[0050] Next, the operation is explained. The control signal of Logic H is inputted into Terminal SEL from the circuit which is not illustrated at the time of a recording mode. At this time, a selector 81 outputs the data inputted into the input terminal DB, and the data of an inphase from the output terminal Q, and outputs the data of an opposite phase from the output terminal QI. This data is supplied to the NPN transistor 31 in drawing 6 , and the base of 32, respectively.

[0051] On the other hand, the control signal of Logic L is inputted into Terminal SEL at the time of reproduction mode. At this time, a selector 81 chooses the signal inputted from the input terminal DA, outputs the signal of an inphase to the output terminal Q, and outputs the signal of an opposite phase to the output terminal QI. The signal of the opposite phase outputted from the output terminal QI returns to the input terminal DA again, after only predetermined time amount is delayed by the delay circuit

86. As a result, a ring oscillator is constituted by this selector 81 and delay circuit 86, and the pulse which has a time delay twice the cycle of in the delay circuit 86 from the output terminal QI is generated. This pulse is supplied to the NPN transistor 31 of drawing 6 , and the base of 32 as a RF superposition pulse.

[0052] It is that this ring oscillator is constituted only at the reproduction mode time. Therefore, a possibility that unnecessary radiation may occur so much decreases.

[0053] In the example of drawing 7 , power consumption of a module 38 can be made small and the stability of oscillation frequency can be increased. Moreover, unnecessary radiation is also reduced. Furthermore, since a module 38 is not directly connected to a laser diode 37, even if variation is in the impedance, it is prevented by the rod of a laser diode 37 etc. that oscillation frequency changes. Moreover, in order to perform switching operation fundamentally, the efficiency of a module 38 becomes good.

[0054] Drawing 8 shows the output wave at the time of driving a laser diode 37 at 1mW and 6mW by composition of drawing 7 . This drawing shows that high-speed switching is performed enough.

[0055] Drawing 9 shows the example of further others. The module 38 is connected to the node of the collector of the NPN transistor 32, and the collector of the PNP transistor 61 in this example.

[0056] Thus, when constituted, compared with the case where it constitutes as shown in drawing 6 , the amount of current which a module 38 outputs becomes large, but compared with the case where a module 38 is connected to the anode of a laser diode 37, the output current of a module 38 can be made small.

[0057]

[Effect of the Invention] According to the laser diode drive circuit of this invention, a constant current circuit is connected between a switching transistor and a laser diode like the above. Since it was made to flow into a laser diode through current n times the size of the current which flows into a switching transistor, power consumption can be made small. Moreover, since the number of the transistors which send a high current becomes fewer, it becomes possible to make circuit structure small. Furthermore, it becomes more nearly switchable [a high speed].